TEST EQUIP.

TP-100
TP-300

MP MASTER
MA34251

LING Electronics

A DIVISION OF LTV LING ALTEC, Inc.

INSTRUCTION MANUAL

MODEL

TP-100/TP-300

POWER AMPLIFIERS

IN ALL CORRESPONDENCE WITH THE FACTORY BE SURE TO INCLUDE THE FOLLOWING INFORMATION:

EQUIPMENT MODEL NUMBER

SERIAL NO. 12, 13, 14

LING NO. 42674

LING Electronics

A DIVISION OF LTV LING ALTEC, Inc.
1515 S. MANCHESTER AVENUE, ANAHEIM, CALIFORNIA 92803 (714)774-2000

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SAFETY NOTICE

This apparatus has been designed so as to afford all personnel maximum protection from electrical shocks and burns. The cubicle is fitted with control circuit interlocks of high-voltage AC and DC shorting switches which are actuated by the rear access door. The interlocks open the power supply contactors while the shorting switch shorts the positive and negative terminals of the rectifiers. Thus, double protection against contact with high-voltage circuits is afforded operating and maintenance personnel. Moreover, a second interlock operates a contactor which disconnects the primary voltage from all exposed terminals.

While every practical safety precaution has been incorporated in this equipment, the following rules should be strictly observed:

1. KEEP AWAY FROM LIVE CIRCUITS. Under NO Circumstances should any person be permitted to reach within or in any manner gain access to the cabinet with the interlocked door closed (or with power supply line switches to the equipment closed); or to approach or handle any portion of the equipment which is supplied with power; or to connect any apparatus external to the enclosure to circuits within the equipment; or to apply voltages to the equipment for testing purposes while any non-interlocked portion of the shielding or enclosure is removed or opened.

2. DO NOT SERVICE OR ADJUST ALONE. Under NO Circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

3. DO NOT TAMPER WITH INTERLOCKS. Under NO Circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with.

4. FIRST AID. Study first aid procedures in handling electrical shock.

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SECTION 1 - DESCRIPTION

1-1. INTRODUCTION

a. Scope.

This instruction manual describes the operation, principles, and maintenance of the Ling Model TP-100 and TP-300 Power Amplifiers. Supplementary documentation is provided for any accessory equipment or assemblies delivered with this unit, but which are not covered by this instruction manual. Refer to Section 5 for a list of applicable engineering drawings, supplementary documentation, information on modifications (if any) to the standard model, and other supporting data.

b. Purpose.

The Model TP-100 and TP-300 amplifiers are used to drive a one-half to two ohm load at rated output power over a frequency range of dc to 30 kilocycles. Typically, the amplifiers are used to drive shakers for vibration testing or transducers for high-intensity acoustical testing. However, their use is not limited to these applications. Both amplifiers include space for output transformers to drive higher impedance loads.

c. Physical description.

(1) The entire amplifier of either model is housed in a standard 19-inch rack-mount chassis which requires seven inches of panel height.

(2) A small fan at the rear of the amplifier exhausts hot air. Incoming air flows through vents and a washable foam-type filter at the side(s) of the unit to cool the heat-producing components.

d. Electrical description.

(1) The amplifier features modularized transistor circuitry and consists of a pre-amplifier card driving a bridged, dual-assembly, output configuration. The configuration is described in paragraph 3-1. Several output options are available and are listed in paragraph 1-4. The unit has a built-in solid-state power supply.

(2) Basic fault-protection of the Model TP-100 is provided by fast-blow fuses. The Model TP-300 incorporates a printed circuit card with more elaborate circuitry to provide over-current, over-temperature, and shaker overtravel protection. The dash 3 and dash 7 versions of the Model TP-100 have interlocks associated with the air pressure system; these versions are used to drive Ling electropneumatic/acoustic transducers.

(3) A thermocouple-type ammeter is normally included on the front panel to provide output current indication.

(4) All operating controls are mounted on the front panel.

1-2. ASSEMBLIES

a. Model TP-100 amplifier.

ASSEMBLY NUMBER	TITLE
44454	Preamplifier Card
44401	Positive Driver/Final Assembly
44402	Negative Driver/Final Assembly

b. Model TP-300 amplifier.

ASSEMBLY NUMBER	TITLE
44454	Preamplifier Card
44401	Positive Driver/Final Assembly
44402	Negative Driver/Final Assembly
44403	Final Assembly (2)*
44451	Fault-Protection Circuit Card

*In the Model TP-300 the two additional final assemblies (one in parallel with the positive driver/final and the other in parallel with the negative driver/final) are used to provide the increased power capability.

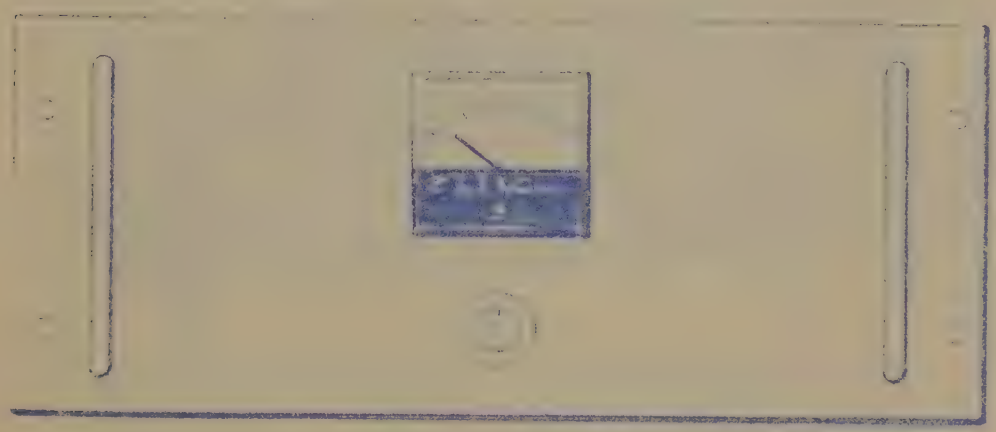

Fig. 1-1 Model TP-100 Amplifier, Front View

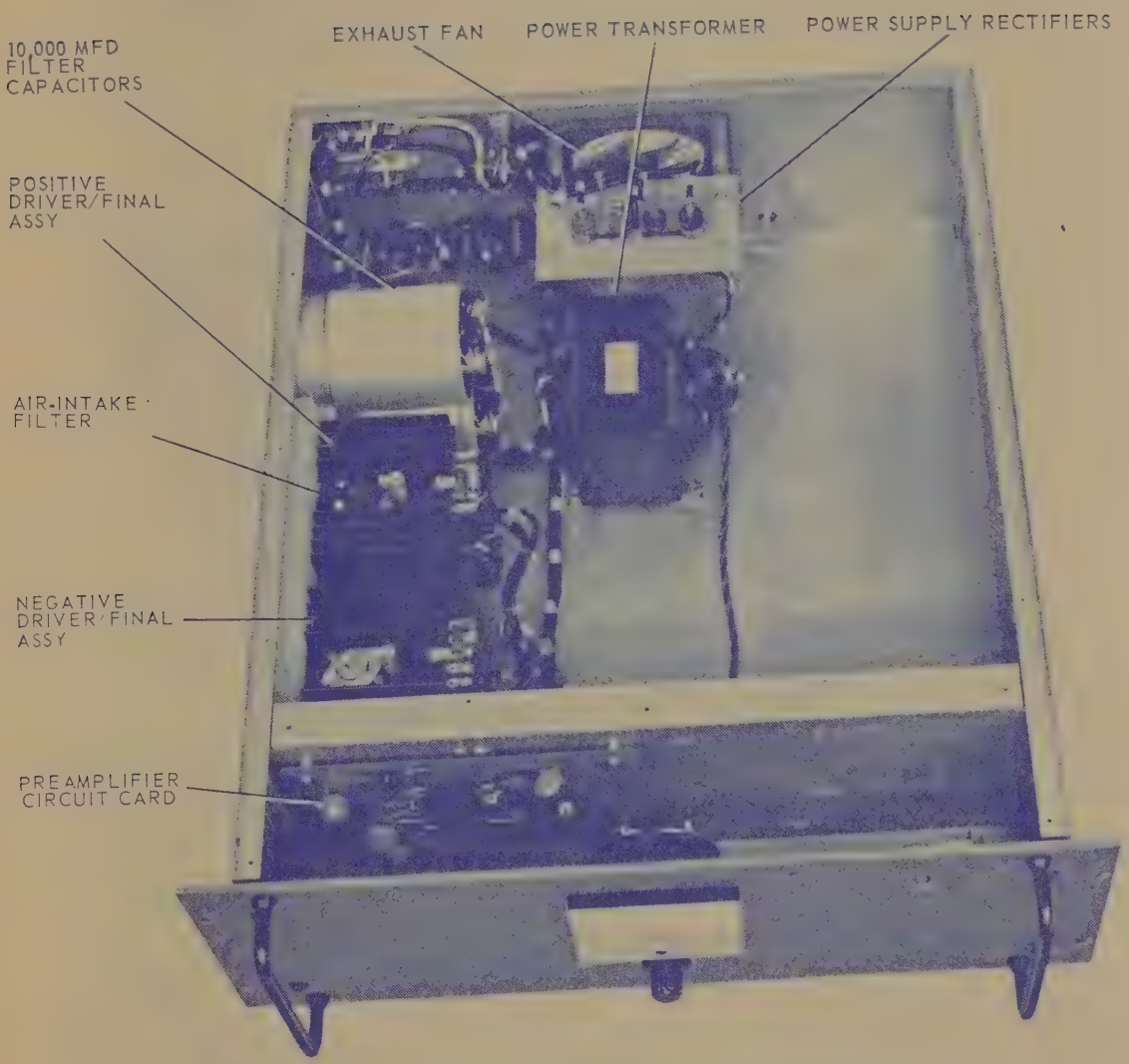

Fig. 1-2A Model TP-100 Amplifier, Top View with Cover Removed

Fig. 1-3A Model TP-100 Amplifier, Rear View

1-3. REFERENCE DATA

a. Model TP-100 (dash 1 through dash 8 versions)

(1). TP-100-1

This version is a dc-coupled amplifier for driving a 1 to 2 ohm load.

Output Power	100 va max.
Dissipation	200 watts, max., continuous
Output Voltage	14.5v rms, 20 vdc max.
Output Current	10 amps rms, 10 adc max.
Output Impedance	0.05 ohm.
Frequency Response	±0.5 db, dc to 20 kc.
Distortion	Less than 1%, dc to 20 kc. Less than 3%, dc to 30 kc.
Noise	80 db below full output.
Input Voltage	Less than 3v rms for rated output.
Input Impedance	10,000 ohms.
Input Power Requirements	105 to 125v, 50/60 cps, 300 va.
Heat Rejected to Air	700 BTU/HR max.
Size:	
Length	19 in.
Depth	22 in.
Height	7 in.
Weight	approx. 30 lbs.

(2). Model TP-100-2

Similar to TP-100-1 but also includes an output transformer for matching the output to the Goodmans V50 shaker. Other differences as follows:

Frequency Response	+0.5 db, 33 cps to 5 kc. Below 33 cps, output voltage is proportional to frequency.
Distortion	Less than 1%, 50 cps to 3 kc. Less than 3%, 33 cps to 5 kc.
Weight	Approx. 64 lbs.

(3). TP-100-3.

Similar to the TP-100-1 but intended for use with Ling Electronics electropneumatic transducers. Has air pressure gauge and interlocks.

(4). Model TP-100-4.

A low-cost version of the TP-100-1. No meters or handles.

(5). Model TP-100-5.

Same as TP-100-1 except only 1 volt rms input is needed to produce full output power instead of 3 volts rms.

(6). Model TP-100-6.

Same as TP-100-2 except only 1 volt rms input is needed to produce full output power instead of 3 volts rms.

(7). Model TP-100-7.

Same as TP-100-3 except only 1 volt rms input is needed to produce full output power instead of 3 volts rms.

(8). Model TP-100-8.

Same as TP-100-4 except only 1 volt rms input is needed to produce full output power instead of 3 volts rms.

b. Model TP-300 (dash 1 through dash 4 versions)

(1). TP-300-1.

This version is a dc-coupled amplifier for driving a 1/2 to 1 ohm load.

Output Power	300 va max.
Dissipation	600 watts, max., continuous.
Output Voltage	14.5v rms, 20 vdc max.
Output Current	21 amps rms, 30 adc max.
Output Impedance	0.05 ohm.
Frequency Response	±.5 db, dc to 20 kc.
Distortion	Less than 1%, dc to 20 kc. Less than 3%, dc to 30 kc.
Noise	80 db below full output.
Input Voltage	Less than 3 vrms for rated output.
Input Impedance	10,000 ohms.
Input Power Requirements	105 to 125v, 50/60 cps, 900 VA.
Heat Rejected to Air	2000 BTU/HR max.
Size:	
Length	19 in.
Depth	22 in.
Height	7 in.
Weight	Approx. 60 lbs.

(2). TP-300-2.

Similar to the TP-300-1 but also includes an output transformer for matching the output to the Goodman's V50 shaker. Other differences are as follows:

Frequency Response	±0.5 db, 33 cps to 5 kc.
Distortion	Less than 1%, 50 cps to 3 kc. Less than 3%, 33 cps to 5 kc.
Weight	Approx. 100 lbs.

(3). TP-300-3.

Same as the TP-300-1, except only 1 volt rms is needed to produce full output power instead of 3 volts rms.

(4). TP-300-4.

Same as the TP-300-2, except only 1 volt rms is needed to produce full output power instead of 3 volts rms.

SECTION 2 - INSTALLATION AND OPERATION

2-1. INTRODUCTION

a. When the shipment is received, inspect all packages for shipping damage before signing acceptance. Check for loose, broken, and/or damaged components. In the event of shipping damage, notify the agent of the delivering carrier, and obtain a full report of the irregularity, signed by the agent, before accepting the shipment.

b. Installation and interconnection of the unit into the system is normally accomplished by the customer. If technical assistance is desired, arrangements for assistance may be made through the Field Service Department. East of the Mississippi River, contact the Eastern Field Service Office of Ling Electronics, a Division of LTV Ling Altec, Inc., 120 Cross Street, Winchester, Massachusetts. West of the Mississippi River, contact the Western Field Service Office of Ling Electronics, a Division of LTV Ling Altec Inc., 1515 South Manchester Avenue, Anaheim, California.

2-2. INSTALLATION

a. Mounting.

The Model TP-100 and TP-300 may be mounted in a standard 19-inch rack. Secure the amplifier to the rack with four screws through the holes provided in the front panel.

b. Power connections.

Connect the line power cord of the amplifier to a standard 105 to 125 volts, single-phase, 50 to 60 cps power receptacle.

c. Input/output connections.

(1). Connect the output of the amplifier from terminal board TB1 to the load as indicated on the schematic drawing for the specific model. Refer to paragraph 5-2 for the list of drawings supplied with this instruction manual.

(2). Connect the signal input to receptacle J1 at the rear of the amplifier, using a shielded cable. Note on the schematic drawing that signal common on this amplifier is not grounded.

2-3. OPERATION

CAUTION

NEVER OPERATE THE MODEL TP-100 OR TP-300 AMPLIFIERS WITH THE TOP REAR COVER REMOVED, THE VENTILATION PORTS OBSTRUCTED, OR THE FAN DISABLED. IF ANY OF THESE CONDITIONS EXIST, THE AIR FLOW PAST THE OUTPUT DRIVER ASSEMBLIES WILL BE INADEQUATE, CAUSING THE ASSEMBLIES TO OVERHEAT AND DESTROY THE OUTPUT TRANSISTORS.

a. Model TP-100 (dash 1, 2, 4, 5, 6, and 8 versions).

(1). Turn-on procedure. Rotate the GAIN control clockwise to close the power switch, applying input power. Adjust GAIN control for desired output.

(2). Turn-off procedure. Rotate the GAIN control fully counter-clockwise to open the power switch.

b. Model TP-100 (dash 3 and 7 versions).

(1). Turn-on procedure. Apply air pressure to the system. Amount of pressure will be indicated on the pressure gauge. Air interlock switch S3, connected in series with the power switch, should close. Rotate the GAIN control clockwise to close the power switch, completing the input power circuit.

(2). Turn-off procedure. Rotate the GAIN control fully counter-clockwise to open the power switch.

(3). Offset procedure. Operate the press-to-read switch on the front panel and adjust the OFFSET potentiometer until desired current is indicated on the zero-center BALANCE ammeter. The press-to-read switch connects the BALANCE meter with one set of contacts and simultaneously opens the input to prevent any offset due to the signal with another set of contacts.

c. Model TP-300 (all dash versions).

(1). Turn-on procedure.

(a) Set GAIN control fully CCW (counterclockwise) until switch is actuated.

(b) Set POWER ON toggle switch to ON position.

(c) Set GAIN control for desired output level as indicated on OUTPUT meter, after the switch is actuated (clockwise).

NOTE

The amplifier will not turn on unless all fault indicator lamps are lit. If a fault occurs while the equipment is operating, the lamp corresponding to the fault will go out and the amplifier will be automatically turned off. In this case, the GAIN control must be turned fully CCW and the fault must be found and corrected before further operation is attempted.

(2). Clip-level adjustment.

(a) The CLIP-LEVEL adjustment limits the input voltage to approximately 3 volts rms to prevent the output from exceeding 14.5 volts rms.

(b) Connect a 1 ohm resistive dummy load of not less than 300 watts across the output terminals. Connect a voltmeter and oscilloscope across the output.

(c) Apply a 1 kc input signal to the Model TP-300 amplifier.

(d) Turn on the amplifier and set the GAIN control for 14.5 volts rms output.

(e) Monitoring the output signal on the oscilloscope, adjust the CLIP-LEVEL control until output signal peaks start to be clipped.

(f) Turn off the amplifier and remove test equipment and dummy load.

(g) Connect normal load and input signal.

(3). Turn-off procedure.

(a) Set GAIN control to minimum position.

(b) Set POWER ON switch to OFF position.

SECTION 3 - PRINCIPLES OF OPERATION

3-1. INTRODUCTION

a. General.

Refer to paragraph 5-2 for a list of all drawings included with this instruction manual, and to figure 3-1 for a block diagram of the configuration.

b. Functional description.

The amplifier consists of a class A preamplifier card driving a dual-assembly, quasi-complementary, bridged output circuit. The preamplifier provides voltage gain and the dual output circuit provides current gain. One assembly of the dual configuration produces positive signal output power and the other assembly produces the negative signal output power. Feedback is applied around both the positive and negative output assemblies as discussed in paragraph 3-2.

3-2. PREAMPLIFIER CARD

a. General.

The preamplifier card is a class A, direct-coupled amplifier. A high order of negative feedback is used to provide stable operation and enhance performance. Because of this the amplifier has a high open-loop gain, but a relatively low closed-loop gain. The preamplifier has a maximum output voltage of approximately 15 volts rms. Separate connections are provided on the preamplifier card connector for 1 and 3-volt input signals. The 1-volt input signal is passed through additional stages of amplification also mounted on the preamplifier card. The 1-volt amplification circuitry is not included on the 3-volt versions of either model. Refer to figure 3-1 for a block diagram of the preamplifier configuration.

b. Circuit description.

(1). The 1-volt preamplifier card consists of two pairs of complementary transistor stages coupled by an emitter-follower. The first pair consists of transistors 2Q1/2Q2 and the second pair consists of Q1/Q2. Transistor 2Q3 is the emitter-follower which couples the two pairs. The combination of 2Q1/2Q2 and 2Q3 comprises the circuitry for additional amplification to provide full output capability at an input of 1 volt rms. Diodes 2CR1 through 2CR6 provide input overvoltage protection against excessive positive or negative signals. Dc feedback through resistor 2R9 compensates dc parameter fluctuations due to temperature and supply voltage variation. The 1-volt input is connected to card terminals Z and E. A jumper between card terminals X and F connects the amplified signal to the second pair of transistors (Q1/Q2) for further voltage amplification.

(2). The 3-volt preamplifier card is the same as the 1-volt card, except the preliminary circuit including 2Q1, 2Q2, and 2Q3, is deleted. The 3-volt rms input is connected between terminals F and E. In either case, the input signal is applied to the base of Q1, amplified and then direct-coupled to the base of Q2. The dual output of the preamplifier is taken off the collector of Q2 across diode string CR5, CR6 and CR7 (figure 3-3). The voltage drop across these diodes is used to establish the quiescent base current for the two driver assemblies. In addition, the diodes form a bias source, which varies with temperature, tending to minimize the variation of quiescent current with temperature.

(3). Potentiometers 2R6 and R6 are dc offset adjustments to provide zero dc output for zero input (one for each input).

(4). External feedback from the output of the amplifier (not preamplifier) is connected through card terminal D. It is applied to the emitters of 2Q1 and Q1 as negative feedback and as positive feedback to the collector of Q2 through bootstrap capacitor C7. The positive feedback lowers the source impedance of the output stages to reduce distortion of the waveshape with increasing load.

3-3. POSITIVE AND NEGATIVE DRIVER/FINAL ASSEMBLIES

a. The positive and negative output driver/final assemblies in conjunction with the plus and minus 40 volts dc power supply form a bridge circuit with the load. Refer to figures 3-1 and 3-3. These stages provide current gain and a low impedance output to drive a low impedance load.

b. The positive driver/final assembly consists of four NPN-type transistors. The first, Q1, serves as a driver for the remaining three, which are paralleled, in an output emitter-follower configuration. The positive assembly is activated when the input signal from the collector of preamplifier output transistor Q2 increases from the quiescent value. Resistor R5 and diode CR1 form a constant current/constant voltage combination. When the input signal from the preamplifier is at the quiescent value, CR1 does not conduct and R5 limits the current supplied to the bases of the three paralleled transistors to a constant quiescent value. When the input signal increases, diode CR1 conducts bypassing R5 and keeping the voltage across R5 constant regardless of the positive input signal variation. Diode CR2 prevents circuit damage due to voltage spikes which might occur due to a collapsing field from an inductive load.

c. The negative driver/final assembly consists of one PNP driver and three paralleled NPN output transistors. The operation is the same as for the positive assembly, except that it functions on decreasing excursions from the input signal quiescent value. Because of the circuit arrangement, the NPN transistors of the negative assembly appear, electrically, to be PNP transistors, resulting in a complementary configuration with the positive assembly. The complementary

configuration provides a low driving impedance on the negative half cycles of signal as well as on the positive half cycles. However, because the circuit arrangement is physically an NPN circuit which is electrically equivalent to a PNP circuit, the configuration is called quasi-complementary.

3-4. FINAL ASSEMBLIES (TP-300 only)

a. General.

Two additional and identical final assemblies are used on the Model TP-300 to increase the output power capability. One of these is in parallel with the final section of the positive driver/final assembly and the other is similarly paralleled with the negative driver/final assembly.

b. Circuit description.

Each of the additional final assemblies consists of four paralleled NPN transistors. The emitter circuit of each transistor has a low-ohm resistor to ensure that the same current flows through each transistor. If current through a given transistor decreases or increases, the change is reflected to the base circuit and automatically compensated. A thermistor is mounted on each assembly to sense excessive temperature.

3-5. OUTPUT CONNECTIONS

CAUTION

THE REACTIVE COMPONENT OF THE LOAD MUST NOT CAUSE THE POWER FACTOR TO BE LESS THAN 0.1 AT ANY FREQUENCY OF OPERATION. OTHERWISE THE DISSIPATION OF THE AMPLIFIER WILL BE EXCESSIVE.

The output connections are made as shown on the schematic for the model specified. Refer to paragraph 5-2 for a list of applicable drawings. Paragraph 1-4 outlines the differences between the various configurations.

3-6. POWER SUPPLY CIRCUIT

a. Model TP-100 Amplifier.

The power supply for the Model TP-100 consists of a solid-state, full-wave bridge rectifier which converts 120 volts, single-phase, ac power to 80 volts dc. The center tap of the power transformer is connected to common, but the output voltages of the supply appears as plus and minus 40 volts dc with respect to common. Common is not grounded, but is brought to the output terminal board for the convenience of the user. The +40 volts dc and the -40 volts dc outputs are each filtered by a 10,000 microfarad capacitor.

b. Model TP-300 Amplifier.

Two power supplies are used with the Model TP-300. The first is a plus and minus 40 volts dc supply similar to the one used for the Model TP-100, except for additional 10,000 microfarad capacitors. The second supplies +28 volts dc to the fault-protection card.

3-7. MONITORING DEVICES

a. Model TP-100 Amplifier.

(1). The monitoring devices for this amplifier consist of a thermocouple-type output ammeter and an on/off indicator lamp. The output ammeter indicates the current flow through the load.

(2). On the dash 3 and dash 7 versions (these versions are used to drive electropneumatic transducers) a zero-center dc ammeter is also provided to indicate the presence of any dc current (offset) in the output. This meter operates in conjunction with a press-to-read switch. An air pressure gauge is also included to indicate the amount of air pressure applied to the system.

b. Model TP-300 Amplifier.

An output ammeter and several indicator lamps constitute the front panel monitoring devices. Two of the lamps indicate the presence of ac input power and dc supply power. Three other lamps are fault indicators for amplifier overtemperature, output overcurrent, and shaker overtravel. The fault lamps are normally lit. If a fault occurs while the amplifier is in operation, the corresponding lamp goes out.

3-8. POWER CONTROL AND INTERLOCK CIRCUITS

a. Model TP-100 Amplifier.

(1). The Model TP-100 amplifier is turned on and off by a front panel switch placed in the primary circuit of the input power transformer.

(2). In addition to the front panel power switch, the dash 3 and dash 7 versions of the TP-100 have an air pressure-controlled-switch in series with the power switch which prevents operation if the air pressure is insufficient.

(3). Fault-protection on the Model TP-100 is provided by fuses in the input power and the dc power supply lines.

b. Model TP-300 Amplifier.

(1). This model uses a series-connected toggle power switch and relay to apply primary input power. The relay (K1) is controlled by a second switch S2 which is ganged with the GAIN control. Switch S2 closes when the GAIN control is set to the minimum position (fully CCW). The purpose of this arrangement is to prevent the amplifier from being turned on when a signal is present. Relay K1 has a latching circuit which bypasses S2 once power is applied.

(2). A fault-protection card is used with this model in addition to fuses. This card is described in paragraph 3-9.

3-9. FAULT-PROTECTION CARD

a. General.

The fault-protection card consists mainly of switching devices to implement the fault-protection function of the Model TP-300. Figure 3-4 is a block diagram of the configuration. A four-layer silicon-controlled-rectifier (scr) controls a relay which disables the output circuit and also the input power when a fault occurs. Additionally, other scrs turn off fault indicator lamps which are normally lit. Fault-protection is provided for output overcurrent, amplifier overtemperature, and shaker overtravel.

b. Circuit description.

(1). Output overcurrent circuit. This circuit senses excessive current through either the positive or negative driver/final assemblies. The circuit consists of transistors Q1, Q2, and Q3. Q1 and Q2 function as complementary switches which are turned on when the output current is excessive in either direction. Output current is sensed as a proportional voltage at the collectors of the output transistors and is applied to the bases of Q1 and Q2 through card connectors C and D, and potentiometers R1 and R2, respectively. The two potentiometers establish the positive and negative trip levels. When the current through the positive output assembly exceeds the trip level, Q1 is turned on, causing its emitter voltage to approach +40 volts dc which is coupled to scr CR2 and steering diode CR8 through emitter follower Q3. CR2 turns on, acting as a short-circuit across the OVERCURRENT lamp and causes it to go out. CR8 becomes forward biased, allowing a positive voltage to reach scr CR4, which turns on to energize relay K2, closing its contacts. One section of K2 disables the output circuit and the other section disables the power supply. A similar action occurs when the negative trip level is exceeded with Q2 turning on instead of Q1.

(2). Overtemperature circuit. Excessive amplifier temperature is sensed by a thermistor mounted on each final assembly and connected to the card at terminals K and M. As heat increases, thermistor resistance decreases, causing Q4 to turn on which, in turn, causes CR3 to turn on and steering diode CR7 to conduct. When CR3 conducts, the OVERTEMPERATURE lamp is shorted and it goes out. When CR7 conducts it turns on CR4 to operate relay K2 as described in (1).

(3). Overtravel circuit. If the shaker displacement is excessive, an overtravel switch at the shaker is actuated. The switch is connected to card terminal X. When the switch closes, a positive voltage is applied to scr CR1 and steering diode CR9. CR1 turns on and shorts out the OVERTRAVEL lamp, causing it to go out. CR9 conducts, causing CR4 to conduct and energize K2 which disables the amplifier.

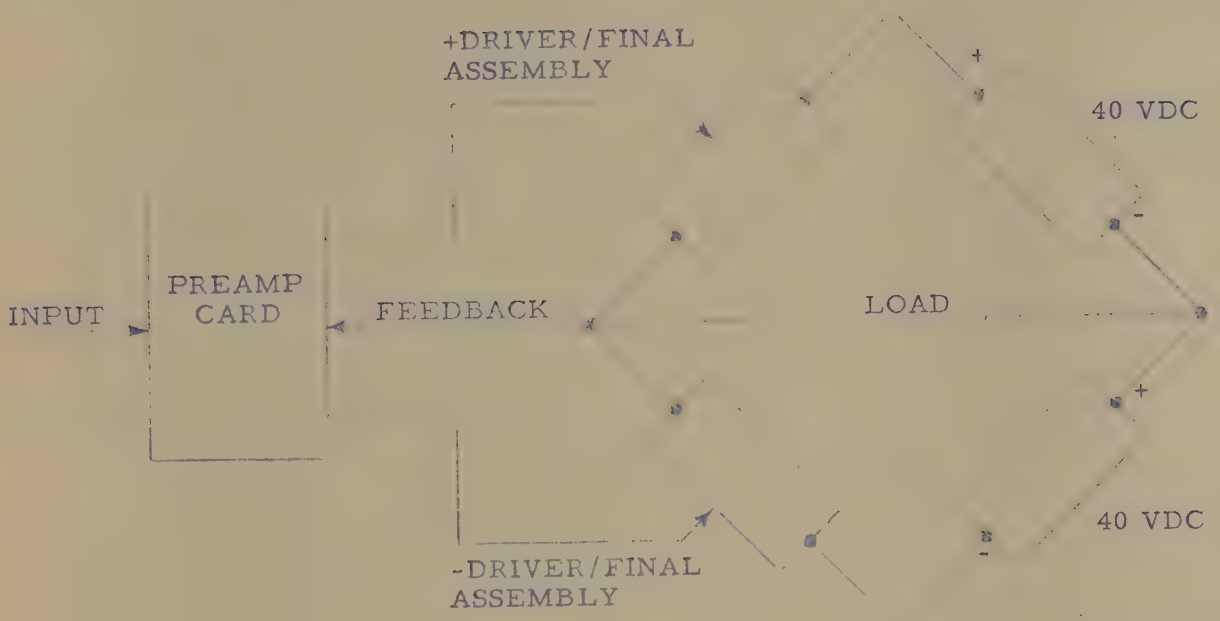

Fig. 3-1 Block Diagram of TP Model Amplifier

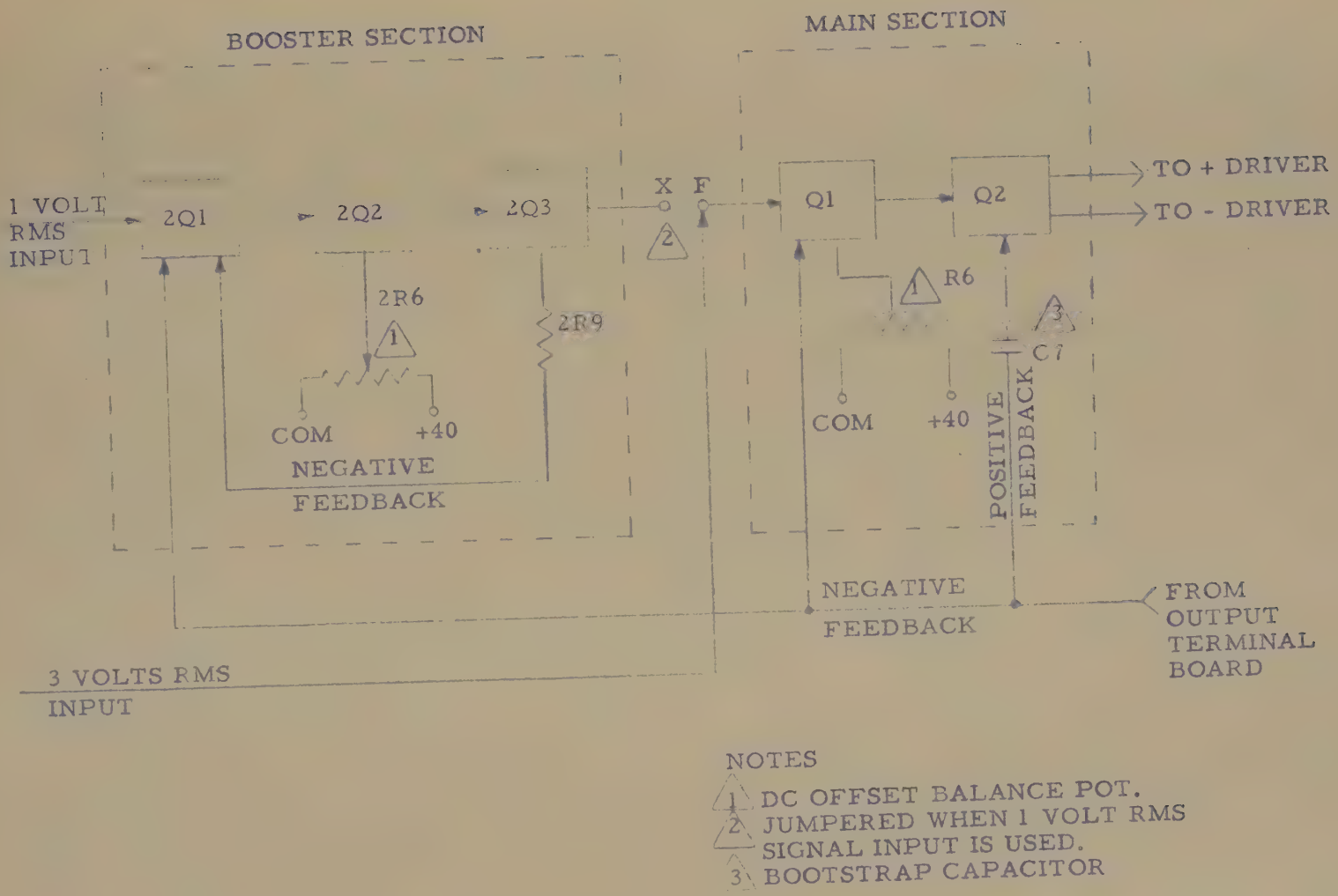

Fig. 3-2 Block Diagram of Preamplifier Card

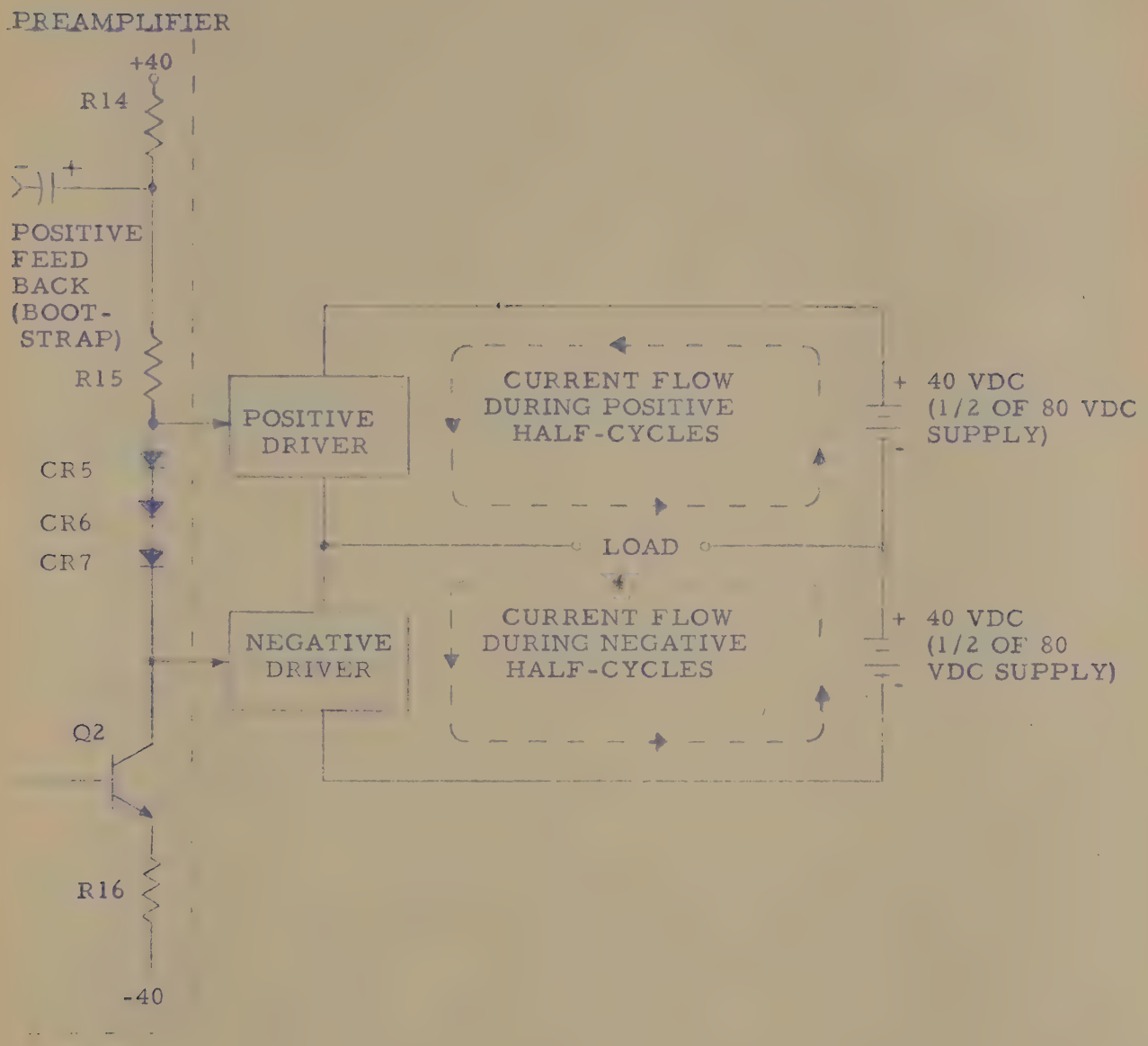

Fig. 3-3 Block Diagram of Driver and Load Configuration

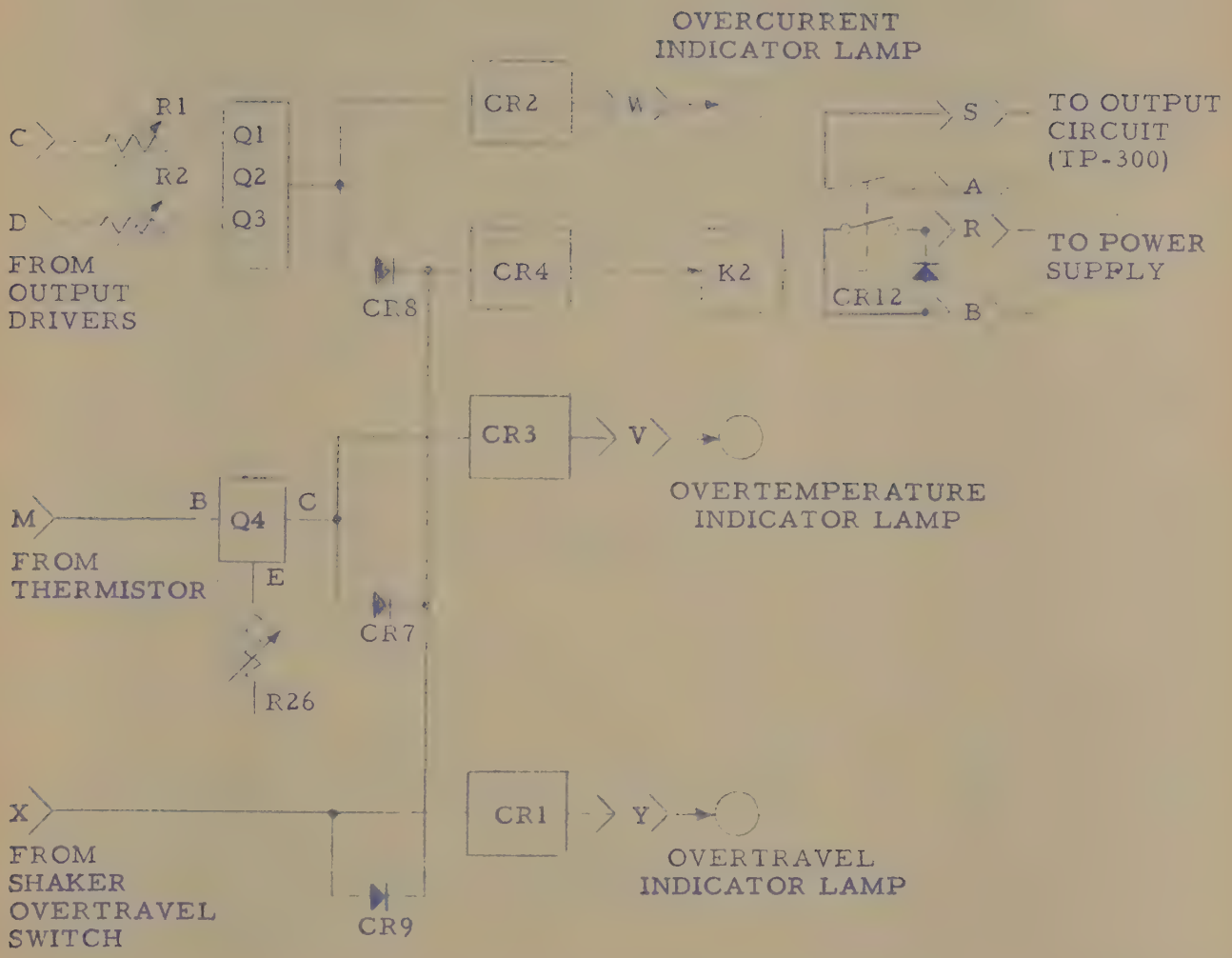

Fig. 3-4 Block Diagram of Fault-Protection Circuit Card

SECTION 4 - MAINTENANCE

4-1. INTRODUCTION

In the event that troubles or problems occur, which are not covered within the scope of this instruction manual contact the Field Service Department. Refer to paragraph 2-1b for addresses. Include in the query, the Ling serial and model numbers, conditions of use, and a full description of the problem. Field Service personnel are always available for consultation in areas concerning utilization and application of Ling equipment. In addition, Ling Electronics conducts a two-week Operations and Maintenance Course, and a one-week Technical Maintenance Course covering all phases of Ling equipment. Further information regarding these courses for customer employees may be obtained by writing to the Vibration School Registrar, Ling Electronics, A Division of LTV Ling Altec Inc. 1515 South Manchester, Anaheim, California 92803.

4-2. TEST EQUIPMENT REQUIRED

a. Multimeter.

Model 270 Simpson or equivalent.

b. Signal generator.

Dc: Krohnhite 440A or equivalent.
Ac: Hewlett-Packard 200 CD or equivalent.

c. Oscilloscope.

Tektronix 515 or equivalent.

d. Resistive load.

Model TP-100: 2 ohms not less than 100 watts.
Model TP-300: 1 ohm not less than 300 watts.

e. Distortion analyzer

Hewlett-Packard HOI-330B or equivalent.

4-3. TROUBLESHOOTING

a. Refer to table 4-1 as a guide to localize the area of a malfunction. The purpose of the table is not to present a complete and comprehensive tabulation of all possible troubles and their causes. The table is intended as a guide to localize trouble by encouraging logical analysis. Possible troubles are listed under the two main headings of non-operation and degraded operation.

b. In the event of a malfunction, a preliminary visual inspection may sometimes reveal the cause, eliminating the need for time-consuming troubleshooting procedures.

CAUTION

NEVER OPERATE THE MODEL TP-100 OR TP-300 AMPLIFIERS WITH THE TOP REAR COVER REMOVED, THE VENTILATION PORTS OBSTRUCTED, OR THE FAN DISABLED. IF ANY OF THESE CONDITIONS EXIST, THE AIR FLOW PAST THE OUTPUT DRIVER ASSEMBLIES WILL BE INADEQUATE, CAUSING THE ASSEMBLIES TO OVERHEAT AND DESTROY THE OUTPUT TRANSISTORS.

TABLE 4-1 TROUBLESHOOTING GUIDE

TROUBLE	PROBABLE CAUSE
NON-OPERATION	
POWER ON lamp does not light when amplifier is turned on.	1. Input power fuse is open. 2. Air interlock switch not closing (dash 3 and dash 7 versions only).
POWER ON lamp lights, but no output is apparent.	1. Input signal not present or improperly connected. 2. GAIN control set fully counter-clockwise. 3. Jumper between terminals X and F of preamplifier card not jumpered (dash 5, 6, 7 and 8 versions of Model TP-100 only). 4. Power supply inoperative, or power supply fuses open. 5. Malfunction in preamplifier card, or card not properly seated. 6. Malfunction in driver/final or final assembly, load not properly connected, or load circuit is open.
DEGRADED OPERATION	
Output power below rated value with GAIN control set to maximum.	1. Defective driver/final or final assembly. 2. Defective preamplifier card. 3. Input signal not properly connected or too low. Note that a signal level of 3 volts rms is required to produce full output when input is connected to terminal F of preamplifier card.

TABLE 4-1 TROUBLESHOOTING GUIDE (cont)

TROUBLE	PROBABLE CAUSE
DEGRADED OPERATION (cont)	
	4. Load not properly matched to output.
Output distortion.	1. Input signal distorted. 2. Defective preamplifier card. 3. Defective output driver/final or final assembly. 4. Feedback loop open.
Excessive noise in output.	1. Input signal defective or not properly connected. Check for ground loops, especially in input circuit. 2. Open shield on input cable or shield ungrounded. 3. Defective preamplifier card, card contacts not mating properly, defective driver/final or final assembly.
Frequency response not within specification.	1. Input signal source defective. 2. Defective preamplifier card, driver/final, or final assembly.

4-4. CALIBRATION AND ADJUSTMENT (TP-100)

a. The Model TP-100 has two internal adjustments (potentiometers 2R6 and R6) which are located on the preamplifier card. These are dc offset balance adjustments which are set at the factory to provide zero dc output for zero input.

b. In the event these adjustments are inadvertently altered, perform the following steps to readjust the settings:

(1). R6 adjustment.

(a). Disconnect the load and the input signal.

(b). Connect a voltmeter across the open output terminals.

(c). Short-circuit the 3-volts rms input at pin F of the preamplifier card to common (pin E).

(d). Turn on the amplifier.

(e). Set potentiometer R6 for zero dc voltage indication on the voltmeter connected across the open-circuited output.

(2). 2R6 adjustment. (Dash 5 to dash 8 versions only.)

(a). Turn off the amplifier.

(b). Disconnect the short-circuit jumper between the 3-volt rms input at pin F and common (pin E) and connect it between the 1-volt rms input at pin Z and common.

(c). Turn on the amplifier.

(d). Set potentiometer 2R6 for zero dc voltage indication on the voltmeter connected across the open-circuited output.

(e). Turn off the amplifier.

(f). Remove the jumper and voltmeter.

(g). Connect the load and input signal.

(3). On the Model TP-100-3 and TP-100-7 versions the OFFSET potentiometer may be used to balance the 3 volts rms amplifier section instead of R6 (assuming R6 has been initially adjusted). This provides convenience because the OFFSET potentiometer is an external control.

4-5. CALIBRATION AND ADJUSTMENT (TP-300)

a. The Model TP-300 has three internal adjustments on the fault-protection card as well as the two on the preamplifier card. These adjustments are made at the factory and should not require re-adjustment.

b. In the event the internal adjustments on the preamplifier card and the fault-protection card are inadvertently altered, proceed as follows:

(1). Preamplifier card. Same as described in paragraph 4-4b, subdivisions (1) and (2).

(2). Fault-protection card. Set potentiometers R1 and R2 so the amplifier turns off when the output current exceeds the maximum permissible positive and negative peak values, respectively. Set potentiometer R26 so the amplifier turns off when the temperature at the sensing thermistor on either output final assembly exceeds the maximum permissible temperature.

SECTION 5 - SUPPORT DOCUMENTATION

5-1. INTRODUCTION

Section 5 lists the engineering drawings which accompany this instruction manual, any supplementary documentation included, recommended spare parts, and options available through the use of accessories. Also, this section lists and describes any modifications made to the standard model which apply to this unit.

5-2. ENGINEERING DRAWINGS

a. Model TP-100

NUMBER	TITLE
44469	Schematic, TP-100 (dash 1, 2, 4, 5, 6, 8 versions)
44525	Schematic, TP-100 (dash 3 and 7 versions)
44422	Schematic, Preamplifier Card
33455	Schematic, Positive Driver/Final Assembly
33456	Schematic, Negative Driver/Final Assembly

b. Model TP-300

NUMBER	TITLE
6138	Schematic, TP-300 (dash 1, 2, 3, and 4)
44522	Schematic, Fault-Protection Card
44422	Schematic, Preamplifier Card
33455	Schematic, Positive Driver/Final Assembly
33456	Schematic, Negative Driver/Final Assembly
33457	Schematic, Final Assembly

5-3. OTHER DOCUMENTATION

An engineering parts list accompanies this manual.

5-4. RECOMMENDED SPARE PARTS

Refer to column marked RS on the Engineering Parts List accompanying this manual for quantities of recommended spare parts.

ENGINEERING PARTS LIST

DATE _____ PAGE _____ MANUAL _____
REV. _____ CONT'D ON _____ REQUISITION NO. _____

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DATE
TP-100-1	12,13,14	4079	42674				

REV.	ITEM	*R.S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCHASE ORDER
				44319-1	Front Panel			-	-			
	45			44354	Final Detail - Front Panel			1	1			
				22719	Nameplate, Meter			1	1			
				TP-100 Basic	Power Amplifier (See own EPL)			1	1			

*R.S. - RECOMMENDED AS CUSTOMER SPARES

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ENGINEERING PARTS LIST

DATE _____ PAGE _____ MANUAL _____

REV. _____ CONT'D ON _____ REQUISITION NO. _____

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DATE
TP-100-1							

REV.	ITEM	*R.S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCHASE ORDER
	39		XDS5	82186-0047	Lamp Holder Bayonet	DIALCO	755	1	1			
	38			82186-0048	Lens Assembly Flat, Red Black Nickel Finish	DIALCO	5006-371B	1	1			
	37	1	DS5	82185-0034	Lamp, 55V	DIALCO	1835 or equiv.	1	1			
	35			82136-0011	Handle	GAXY	28-30	2	2			
	34			80115-0021	Knob	RAY	70-3-2G	1	1			
	40		R6 S2	PS-10925-2	Potentiometer			1	1			
	41		M1	PS-10964-2	Meter, 0-10 Amp			1	1			
	36			82136-0008	Handle, Ferrule	GAXY	205	4	4			
	42		R5	82269-0047	Resistor .066 ohm 10W 1%	CAL-R	Type SAX-100	1	1			

*R.S. - RECOMMENDED AS CUSTOMER SPARES

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ENGINEERING PARTS LIST

DATE _____ PAGE _____ MANUAL _____

REV. _____ CONT'D ON _____ REQUISITION NO. _____

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DAT
TP-100-1							

REV.	INFO.	*R.S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCH ORD
					Items on this page are for converting the 44456 Basic P.C. Card Assembly to 44456-1 P.C. Card Assembly.							
			R3	82230-0511J	Resistor 510 ohm 1/2W			1	1			
			R4	82230-0510J	Resistor 51 ohm 1/2W			1	2			
			R5		Resistor 51 ohm 1/2W			1	-			
			R10	82230-0332J	Resistor 3.3K 1/2W			1	1			
			R15	82258-0501J	Resistor 500 ohm 10W			1	1			
			R20	82230-0391J	Resistor 390 ohm 1/2W			1	2			
			R21		Resistor 390 ohm 1/2W			1	-			
			R22	82230-0910J	Resistor 91 ohm 1/2W			1	1			
			C5	82027-0101K	Capacitor 100 pf 500V			1	1			
			C6	82027-0271K	Capacitor 270 pf 500V			1	1			

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ENGINEERING PARTS LIST

DATE 7-21-66 PAGE 1 MANUAL
REV. F CONT'D ON 2 REQUISITION NO.

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	P.O.	QTY.	ACCOUNT NO.	M-DAY	DATE
TP-100 Basic	12,13,14		52674				

REV.	ITEM NO.	*R.S.	SYMBOL DESIG.	STOCK DWG NUMBER	DESCRIPTION	MFG. CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCHASE ORDER
F				44469	Schematic - TP-100			-	-			
F				50164	Component Layout			-	-			
E												
D												
D												
C												
C												
B												
B												
A												
A												

*R.S. - RECOMMENDED AS FIELD CUSTOMER SPARES

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ENGINEERING PARTS LIST

DATE 3-12-62 PAGE 2 MANUAL
REV. D CONT'D ON 3 REQUISITION NO.

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PGN	QTY.	ACCOUNT NO.	M-DAY	DAT
TP-100 Basic							

REV.	IND.	*R.S.	SYMBOL DESIG.	STOCK DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	SCRAP	KARDEX	PURCH ORDER
	1			6098	Chassis			1	1			
	2			33246	Cover, Rear			1	1			
	3			22426	Cover, Front			1	1			
	4		A3	44401	Driver (+) Transistor Assembly Power Amplifier (See own EPL)			1	1			
	5		A4	44402	Driver (-) Transistor Assembly Power Amplifier (See own EPL)			1	1			
	6			22605	Plate Rectifier			1	1			
	7			33460	Cover, Chassis Side			1	1			
	8			22445	Plate, Hole Reducer			1	1			
	9			33253	Filter			1	1			
	10		A1	44456	Preamp P.C. Card Assembly (See own EPL)			1	1			
	47			22608	Cover, Heat Sink			1	1			
				22752	Bracket - Module			1	1			

*R.S. - RECOMMENDED AS CUSTOMER SPARES

ENGINEERING PARTS LIST

DATE 9-21-67 PAGE 3 MANUAL
REV. F CONT'D ON 4 REQUISITION NO.

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DATE
TP 100 Basic							

REV.	ITEM NO.	*R. S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCHASE ORDER
	11		C1	83001-1003	Capacitor 10,000µf/50V	MA	CG14U50F1	1	2			
	11		C2		Capacitor 10,000µf/50V	MA	CG14U50F1	1	-			
C	12		XC1-XC2	82011-6045	Bracket, Capacitor 3"	SA	DCM-11	2	2			
EE			C3	82060-0502	Capacitor, Ceramic Disc 0.005 µf			1	1			
	13		CR1	82110-0096	Rectifier		SR1141	1	2			
	13		CR2		Rectifier		SR1141	1	-			
	14		CR3	82110-0097	Rectifier		SR1141R	1	2			
	14		CR4		Rectifier		SR1141R	1	-			
A	15			82012-0047	Bracket	USECO	11-3	2	2			
B	16			82012-0048	Bracket	STERLING INSTRU.	SO46-31	2	2			
D	17		P2	82425-0044	Line Cord	ALPHA	610	1	1			
DX	18			85242-4448	Snap Bushing	HEY	SB-1500-21	1	1			

*R.... - RECOMMENDED AS CUSTOMER SPARES

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ENGINEERING PARTS LIST

DATE [illegible] PAGE 4 MANUAL
REV. B CONT'D ON 5 REQUISITION NO.

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	QTY.	ACCOUNT NO.	M. DAY	DAT
TP 100 Basic						

REV.	ITEM NO.	NR. S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFR CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCH ORDER
	19		B1	80153-0032	Fan 115V 50/60 cycle	HEINZE	4020DEG	1	1			
A	20		T1	82311-0019	Transformer, Power	SIGNAL	56-4	1	1			
	21		XF1	80143-0009	Fuse Holder	LI	344125	1	1			
	22		XF2	80143-0026	Fuse Holder	BUSS	HPC	1	2			
	22		XF3		Fuse Holder	BUSS	HPC	1	-			
	23	1	F1	82145-0017	Fuse 5A SB 3AG			1	1			
	24	2	F2	82145-0057	Fuse, Transistor	BUSS	KAA-10	1	2			
	24		F3		Fuse, Transistor	BUSS	KAA-10	1	-			
	25		TB1	80111-1002	Terminal Strip	CU	GFTA-10	1	1			
B A	26		TB2	80112-0001	Terminal Board	CJ	6-141	1	1			

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ENGINEERING PARTS LIST

DATE 2-21-68 PAGE 3 MANUAL
REV. F CONT'D ON 3.1 REQUISITION NO.

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DAT
TP-100 Basic							

REV.	ITEM NO.	*R.S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCH ORD
	27			81006-0020	Strain Relief Bushing	HEY	SR-6P-1	1	1			
	28			86044-0004	Insulator Strip, 3½ long	TOR	903 or equiv,	8	8			
	29			85181-1206	Standoff 1/4 hex 6-32 x 3/8			2	2			
			J1	80100-0132	Connector	CAN	XLR-3-32	1	1			
	30		J2	80101-0023	Connector	WIN	KZ22S	1	1			
	31			85301-2821	Snap Button			2	2			
	32		TS6 TS7	80112-0075	Terminal Strip	CJ	2006	2	2			
F			TS8	80112-0097	Terminal Strip	CJ		1	1			

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ENGINEERING PARTS LIST

DATE _____ PAGE 1 MANUAL _____

REV. _____ CONT'D ON 2 REQUISITION NO. _____

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DAT
TP-100 Basic							

REV.	ITEM	*R.S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCHA ORDE
F			P1	80100-0097	Connector	CAN	XLR3-11C	1	1			
F				82348-1626	Lead Wire, Grey 16 AWG 600V			AR	AR			
F				82333-1602	Lead Wire, Red 16 AWG 600V			AR	AR			
F				82333-1609	Lead Wire, White 16 AWG 600V			AR	AR			

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ENGINEERING PARTS LIST

DATE 4-22-65 PAGE 6 MANUAL
REV. F CONT'D ON — REQUISITION NO.

MODEL OR ASSY.	SERIAL NO.	SHOP ORDER	PON	QTY.	ACCOUNT NO.	M-DAY	DATE
TP-100 Basic							

REV.	ITEM	*R.S.	SYMBOL DESIG.	STOCK/DWG NUMBER	DESCRIPTION	MFG. CODE	MANUFACTURER PART NUMBER	QTY. ASSY.	QTY. UNIT	CODE	KARDEX	PURCHASE ORDER
			R1	82230-0511K	Resistor 510 ohm 1/2W			1	1			
			R2	82230-0221K	Resistor 220 ohm 1/2W			1	2			
			R3		Resistor 220 ohm 1/2W			1	-			
F			R4	82232-0511J	Resistor 510 ohm 2W			1	1			

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CODE TO MANUFACTURERS

AA	AIR ASSOCIATES
AB	ALLEN BRADLEY
AC	ASTRON CORPORATION
ACDC	ACDC ELECTRONICS
AD	ADVANCE RELAY
AD-YU	AD-YU LABS
ADEL	ADEL
ADMS	ADAMS & WESTLAKE
AH & H	ARROW-HART & HEGEMAN
AI	AIRCRAFT
AIRM	AIR MARINE PRODUCTS
ALB	ALBION
ALL	ALLIS CHAMBERS
AMC	AMSCO
AME	AMPERITE CO.
AMM	AMMON INSTRUMENTS INC.
AMP	AMPHENOL
AMPX	AMPEX
AP	AIR PAX
APH	ALPHA
API	AMERICANPAMCOR
APRX	AMPEREX
AQ	AEROQUIP
AR	AEROVOX
ARCO	ARCO ELECTRONICS
ARM	ARMSTRONG CORK CO.
AS	ASSOCIATED SPRING
ASP	ASSEMBLY PRODUCTS
ATLE	ATLEE
AUTO	AUTOMATIC ELECTRIC
BAS	BASSICK
BC	BARBAR COLMAN
BECK	BECKMAN INSTRUMENTS
BEL	BELDEN
BEN	BENDIX
BG	BOSTON GEAR
BI	BIRNBACH
BIRT	BIRTCHER
BLY	BLILEY
BO	BODINE
BOU	BOURNS "TRIMPOT"
BOW	BOWERS
BP	BOGEN-PRESTO
BRE	BREEZE "AERO SEAL"
BRY	BRAYANT
BUD	BUD RADIO
BUCH	BUCHANAN
BUG	BUGGIE
BUR	BURROUGHS
BUSS	BUSSMAN MFG.
B & K	BRUEL & KJAER
C	CHATHAM
CA	CARLING ELECTRIC
CAL	CALIDYNE
CALC	CALIFORNIA CHASSIS
CAN	CANNON
CCI	CONTINENTAL CARBON, INC.
CD	CORNELL DUBILIER
CDM	CURTIS INDUSTRIES
CH	CHICAGO STANDARD TRANS.
CHD	CROUSE HINDS
CHSH	CHASE-SHAWMUT
CI	CINEMA
CJ	CINCH-JONES
CK	CONROY & KNOWLTON
CL	CLARK CONTROLER CO.
CLAR	CLAROSTAT
CM	CMPUTER MEASUREMENTS
CMQP	CHEMQUIP
COR	CORNISH
CP	COMMUNICATION PROD.
CRA	CRAMER CONTROL
CRAF	CRAFTSMAN
CRIT	CRITTENDEN
CRL	CENTRALAB
CRN	CRANE
CT	CHASSIS TRAK
CTS	CH. TELE SUPPLY
CU	CURTIS
CUT	CUTLER HAMMER
D & H	D & H AWNING
DA	DAYTON
DALE	DALE
DECO	DEECO
DEFT	DEECO FELT
DELR	DELRY
DI	DIALITE CORP. (DIALCO)
DICO	DIAMOND MFG. (DICO)
DM	DIAMOND METAL
DOS	DOSSERT
DRAK	DURKEE-ATWOOD
DUC	DUCOMMON
DUM	DUMOND
DY	DYMEC
ECK	ECKTRONICS
ED	EDCLIFF INST.
EDEC	ELECTRO DEVELOPMENT CO.
EE	ELECTRONICS ENCLOSURES
EEW	ELECTRO ENG. WORKS
EF	ELECTRO FAB.
EI	EIMAC
EM	ELECTRO-MEASUREMENTS
ELCO	ELCO
ELDM	ELDEMA
ELME	ELMENCO
ELTC	ELECTRAC
EMC	EMCOR
EMEC	EMEC
EMP	EMPCO
ENDV	ENDEVCO
EP	ENGINEERING PROD.
ER	ERIE
ERA	ELEC. RESEARCH ASSOC.
ERC	ELECTRA RESISTOR CORP.
ES	EAGLE SIGNAL
ESCO	ELECTRO-SWITCH CORP.
ESNA	ELASTIC STOP NUT
ESX	ESSEX
EVER	EVEREST
F	FENWAL
FAN	FANSTEEL
FED	FEDERATED SEMICOND
FED-S	FEDERAL SCREW
FEI	FEDERAL ENTERPRISE, INC.
FF	FEDERAL FASTENING
FP	FISHER-PORTER
FR	FRANZ
FU	FULLER
GA	GATES
GAXY	GALAXY
GC	GENERAL CEMENT
GCON	GENERAL CONTROL
GE	GENERAL ELECTRIC
GLA	GEELAR
GL	GLOBAR
GNI	GENERAL INSTRUMENTS
GR	GENERAL RADIO
GRHL	GRAYHILL
GRIS	GRIGSBY CO.
GU	GUDEMAN
GV	V. V. CONTROL
HAW	HARTWELL
HAYS	HAYS MFG.
HE	HEINEMANN
HEY	HEYCO
HP	HEWLETT-PACKARD
HL	HELIPOT
HOF	HOFFMAN
HOP	HOPKINS
HS	HARDWARE SPEC.
HTD	HUDSON TOOL & DIE
HU	HUBBEL
HY	HYCOR
HYD	HAYDON
HZE	HEINZE
IEI	INT. ELEC. IND.
IERC	INT. ELEC. RESEARCH CORP.
IGNS	INGERSOL RAND
III	INT. INSTRU. INC.
IL	ILSCO
ILG	ILG
IMP	IMPERIAL
INSU	INSULINE
IRC	INT. RESISTOR CORP.
IREC	INT. RECTIFIER CORP.
IS	INSULATION SUPPLY
ITE	ITE CIRCUIT BREAKER
ITT	ITT (FEDERAL)
J	JOHNSON
JAN	JAN HARDWARD MFG.
JE	JEFFERSON
JEN	JENSEN
JNC	JANCO
KENR	KEINER
KH	KRON-HITE
KING	KING
KT	KOOLTRONIC
KU	KULKA
KZ	KURZ-KASCH
LA	LYNCH ASBESTOS
LAMB	LAMBDA
LAR	L. A. RESISTOR
LE	LEACH
LER	LERCO
LI	LITTLE FUSE
LING	LING ELECTRONICS DIV.
LMB	LMB
LP	LAPP
LPD	LA-DEAU PROD.
LUNK	LUNKENHEIMER
M	MILLEN
MA	MALLORY
MD	MICRODOT
ME	METTSCRAFT
MEC	MEC
MH	MINNEAPOLIS HONEYWELL
MICA	MICAMOLD
MIN	MINARIK
ML	MACHLETT
MLR.	MILLER CO.
MMN	MARMON
MN	MARION
MOD	MODULONICS
MON	MONITOR
MOSE	MOSELEY
MOSS	MOSSMAN
MRC	MARCO
MRY	MURRAY
MS	MICROSWITCH
MTRO	MOTOROLA
N	NATIONAL CO.
NC	NATIONAL WIRE & CABLE
NE	NETWORK MFG.
NEI	NATIONAL ELEC. INC.
NEP	NATIONAL ELEC. PROD.
NHBB	NEW HAMP. BALL BEARING
NIBCO	NORTHERN INDIANA BRASS
NL	NATIONAL LOCK
O	OHMITE
OZ	O. Z. ELECTRICAL MFG. CO.
PACR	PACIFIC RESISTOR
PAN	PANDUIT
PANX	PANDUX
PCA	PCA
PE	PEERLESS
PENN	PENN CONTROL
PER	PERMOID
PH	PHILLIPS CON. (PHILTROL)
PHIL	PHILBRICK RESEARCH
PREM.	PREMIER METAL PROD.
PRKR	PARKER ELECTRICAL INST.
PRYN	PRYNE
PTB	POTTER-BRUMFIELD
PY	PYRAMID
QE	QUALITY ELECTRIC
R	ROTRON
RAY	RAYTHEON
RBC	RUBBERCRAFT
RCA	RADIO CORP. OF AMER.
RCC	RADIO CONDENSER CO.
RDL	RADIO DEVELOPMENT LAB
RE	REPUBLIC GLASS
REN	RENBRANDT
ROB	ROBERTSHAW-FULTON CON.
ROME	ROME
RT	RATIGAN
RY	RYTRON
S	SIMPSON
SA	SANGAMO
SAR	SARAN
SCN	SCANBE MFG. CORP.
SE	SERVICE
SEL	SELCO
SEP	STANDARD ELECT. PROD.
SFTM	SAFE-T-MIKE
SH	SHALL CROSS
SI	SIGMA
SIE	SOUTHWESTERN IND. ENG.
SKT	SARKES TARZIAN
SK	SPENCER-KENNEDY-LABS.
SM	STANLEY MORRIS
SMC	SPECIALTIES MFG.
SMI	H. H. SMITH
SOLA	SOLA ELECTRIC
SOR	SORENSON
SP	SPRAGUE
SPR	SUPREME
SQ	SQUARE D
SR	SIERRA ELECT. CORP.
SREC	STANDARD RECTIFIER
SS	SPECTRA-STRIP
STAH	STAHLIN BROS.
STAN	STANTRON
STHC	SOUTH CO
STIM	STIMSON, E. B.
STW	STANDARD WIRE & CABLE
SU	SUPERIOR ELECTRIC
SUPT	SUPRENANT
SW	SWITCHCRAFT
SW-CT	SWITCHING CONTROL
SWGL	SWAGELOCK
SY	SYLVANIA
T	TRIAD
T & B	T & B (CONNECTORS)
TCC	TECHNO-COMPONENTS CORP.
TH	THERMADOR
THR	THERMALOY CO.
TI	TEXAS INSTRUMENT
TIC	TECHNOLOGY INST. CORP.
TNG	TUNGSOL
TR	TRUMBEL
TRAN	TRANSELECTRONICS
TRE	TRERICE
TRIM	TRIMM
TRID	TRID LABS. INC.
TX	TEKTRONIX
UI	UNISTRUT
ULAN	ULANET CO., GEO.
UN	UNIMAX
USDC	U.S. ELECT. DEVEL.
USEC	U.S. ENG. CO.
USG	U.S. GAUGE
UTAH	UTAH
UTC	UNITED TRANSFORMER
VAL	VALOR INSTRUMENTS INC.
VEECO	VEECO
VIK	VIKING
VYR	VEYOR CORP.
WA	WALSCO
WAFD	WAKEFIELD ENGR.
WAT	WATERS
WB	WARNER BRAKE
WE	WESTINGHOUSE
WEL	WELWYN
WES	WESTON
WH	WAHLGREN
WHD	WEATHERHEAD
WHIT	WHITLOCK
WIN	WINCHESTER
WK	WECKESSER
WL	WARD LEONARD
WP	WESTCAP
WRMD	WIRE MOULD
WRNE	WESTERN ELECTRIC
WSPT	WESTPORT
WYCO	WYCO METAL PROD.
YO	YOUNG RADIATOR

Ling equipment is manufactured under one or more of the following patents:

2,599,036	Electrodynamic Reciprocation Apparatus
2,789,237	Electrodynamic Vibration Test Equipment
2,810,842	Vibration Generator
2,820,161	Electromagnetic Vibration Generator
2,835,832	Vibration Generating Apparatus
2,846,597	Leakage Flux Compensating Coil
2,846,598	Vibration Generator
2,925,503	Vibration Test Apparatus
3,018,541	Armature Assembly
3,004,178	Vibration Generator
3,049,913	Environmental Test Apparatus
2,502,132	Pickup on Acceleration Recorders
2,944,194	Four Pole Transducer
2,907,838	Electrical Equalizer in Amplifier Circuit
2,935,671	Power Controlling Electrical Circuit
2,888,526	Peak and Notch Filters
2,844,777	Vibration Servo Amplifiers
2,935,672	Displacement-Acceleration Control Circuits
2,985,840	Gain Control Amplifier
3,010,099	Multiple Limiter-Clipper Amplifiers

Trademark Sine-O-Matic 687,926

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